





# Daramend® Bioremediation of Soils Containing Chlorophenols and Polynuclear Aromatic Hydrocarbons

*"DARAMEND bioremediation is a performance proven and cost effective remediation technology for use with soils affected by toxic organic chemicals. The technology has now been expanded to include remediation of soils/sediments containing organochlorine pesticides, nitroaromatics and phthalates. International applications of the technology are under way."*

Dr. Alan G. Seech  
Director of Operations  
GRACE Bioremediation Technologies  
Mississauga, Ontario

In-Situ Treatment				Ex-Situ Treatment		
Parameter (mg/kg)	Initial	Interim	Final	Parameter (mg/kg)	Initial	Final
Number of areas out of 49 above CCME				Treatment Cell 1		
CP	17	2	0	CP	156.8	4.9
PAH	10	5	0	PAH	439	87
Range of concentrations in areas above CCME				Treatment Cell 2		
CP	5.7-27.8	5.5-6.9	all <CCME	CP	102.1	1.63
PAH	69-622	102-176	all <CCME	PAH	619	79.1

*Summary of results from in-situ and ex-situ full-scale demonstration of DARAMEND bioremediation.*

## THE COMPANY

GRACE Bioremediation Technologies (GRACE) is a division of W.R. GRACE & Co. of Canada. The company specializes in development, demonstration and commercial application of innovative technologies for bioremediation of soils and sediments contaminated with toxic organic compounds. Ongoing research has led to the development of DARAMEND bioremediation and the ability to apply the technology widely. GRACE has always been committed to developing environmentally friendly treatment and disposal options and this tradition continues with the DARAMEND technology.

## THE CHALLENGE

Because of past industrial practices, various organic chemicals have been deposited in the soils and sediments at industrial sites. While many of these chemicals could eventually break down naturally, they are either very slow to react and/or have made the soil water resistant, greatly decreasing the possibility of biological activity. Citizens' groups, which recently have become interested in the remediation of local sites, are generally supportive of natural, non-intrusive technologies to remediate or clean up sites. DARAMEND bioremediation ful-

fills the requirement of being natural and non-intrusive while still being an effective remediation technology.

## TECHNOLOGY DESCRIPTION

The DARAMEND Bioremediation Technology was developed by GRACE in co-ordination with Environment Canada and the Ministry of the Environment. The DARAMEND approach to bioremediation is based on the principle of favorably altering the environment within the composition and structure of the soil to enable microorganisms to break down the pollutants. This is accomplished through strict control of moisture content, a specialized tillage system to mix oxygen into the soil and to mix in proprietary organic additions which are specific to the soil, and that will provide new, uncontaminated sites for microbial growth.

## TECHNOLOGY DEMONSTRATION

Pilot and full-scale demonstrations were conducted from the summer of 1991 to the summer of 1994. Field work involved the demonstration of the technology, both on site and off site.

The full-scale in-situ demonstration was designed to treat an area of the site approximately 4,800 square

meters in size to a depth of 0.6 m. This is approximately 3,500 tonnes of soil. The 4,800 square meters was divided into 49 separate sampling areas of approximately 100 square meters each.

During the ex-situ full-scale demonstration, approximately 1,500 tonnes of excavated soil was treated using DARAMEND bioremediation in two fully contained treatment cells.

In both demonstrations, DARAMEND product was applied to the soil at a rate determined by the pre-treatment concentrations of the target compound and the physical and chemical properties of the soil. Results from both bench-scale and pilot-scale work at the site were evaluated in the selection of the amendment. The required mass of product was placed on the soil surface and incorporated to a depth of 0.6 m with a specialized tractor-mounted rotary tiller.

The in-situ demonstration area was tilled twice monthly to ensure continued uniformity of treatment with depth and to add oxygen to the soil. Soil in the ex-situ treatment cells was tilled once a week to ensure continued uniformity of treatment with depth and to add oxygen to the soil. No tilling was done in January, February or March of

1994. Soil moisture content was not controlled.

A portion of the ex-situ Treatment Cell 2 demonstration was monitored by the US EPA under the SITE demonstration program.

## RESULTS

The influence of DARAMEND bioremediation on the chlorophenol and polynuclear aromatic hydrocarbon (PAH) concentrations in the soils was monitored through successive samplings. All analyses were done by an independent lab, Wastewater Technology Centre, Water Technology International Corporation.

The results of the on site and off site demonstrations indicate that DARAMEND bioremediation is an effective remediation method for soils containing chlorophenols (treated soils concentration ranged from 5.7 to 157 mg/kg) and PAHs (concentrations ranged from 69 to 622 mg/kg). The chlorinated phenol and PAH concentrations can be reduced to below the criteria of the Canadian Council of Ministers of Environment (CCME) for industrial soils (5 mg CP/kg and 10-50 mg individual PAH/kg).

Field-scale results were similar to, or exceeded, those results which had been achieved previously in bench-scale and pilot-scale work.

## TECHNOLOGY OPPORTUNITIES

Characteristics of DARAMEND bioremediation are:

- \* mobile technology
- \* low set-up cost
- \* cost effective
- \* no additional waste generated
- \* non-intrusive

Many industrial sites which have had toxic organic chemicals deposited on them are now either being cleaned up by voluntary efforts or are being required to be cleaned up under legislation. DARAMEND bioremediation is an attractive remediation alternative to other technologies because it is cost effective and because it appeals to local citizens' groups as a natural, non-intrusive technology.

## PARTNERSHIP IN POLLUTION PREVENTION AND RESOURCE CONSERVATION

Bench, pilot, and full-scale demonstrations, completed in 1994, of this technology were supported in part by the Ontario Ministry of the Environment. This support was provided in co-operation with Environment Canada under the joint federal and provincial Development and Demonstration of Site Remediation Technologies program.

Industrial companies located in Ontario may seek ministry/industry services which will help them to:

- \* reduce, reuse and recycle solid waste;
- \* clean up historic pollution effectively and destroy hazardous contaminants;
- \* reduce or eliminate liquid effluent and gaseous emissions;
- \* use energy and water more efficiently.

Equipment and service supply companies can benefit from the information provided on technologies identified for business development.

## FOR FURTHER INFORMATION, PLEASE CONTACT:

Dr. Alan Seech  
Director of Operations  
GRACE Bioremediation Technologies  
P.O. Box 3060, Station A  
Mississauga, Ontario  
L5A 3T5  
Tel: (905) 279-2222  
Fax: (905) 272-7472

George Rocoski  
Waste Reduction Branch  
Ministry of the Environment  
40 St. Clair Ave W.  
Toronto, Ontario  
M4V 1M2  
Tel: (416) 314-4165  
Fax: (416) 314-7978

Kirsten Mania  
Industry Conservation Branch  
Ministry of the Environment  
2 St. Clair Ave. W., 14th floor  
Toronto, Ontario  
M4V 1L5  
Tel: (416) 327-8072  
Fax: (416) 327-1261  
INTERNET: maniak@gov.on.ca

## MINISTRY OF THE ENVIRONMENT SERVICES

For information on Ministry of the Environment assistance to industry, please contact the Industry Conservation Branch at (416) 327-1492, Fax (416) 327-1261.

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